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Heliogyro-Configured Solar Sail Spacecraft

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Solar Photons - Solar Sail Missions

Heliophysics Missions

Solar sails are not only able to balance at L_1, L_2,…,L_5 points but they are station-keeping at other regions in space without using fuel on board

De-orbit end of life satellites

L_1

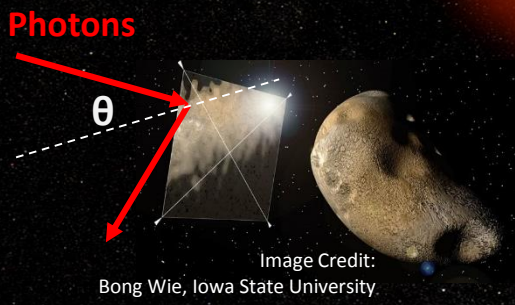
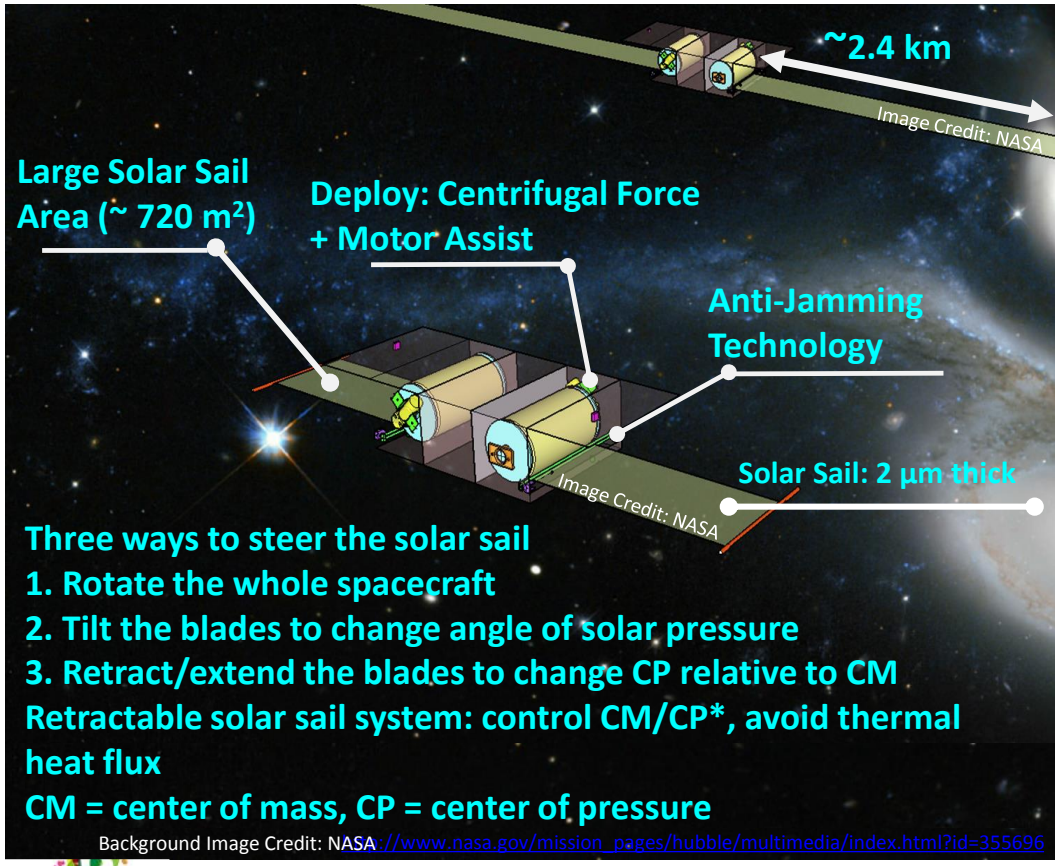


Image Credit:
Bong Wie, Iowa State University

Asteroid Mapping
Asteroid Redirect
Near Earth Object Monitoring

Background Image Credit: NASA http://www.nasa.gov/centers/marshall/images/content/112448main_solar_sail_sun_earth_frame0016_4000x3000.jpg

2-Bladed Heliogyro Solar Sail

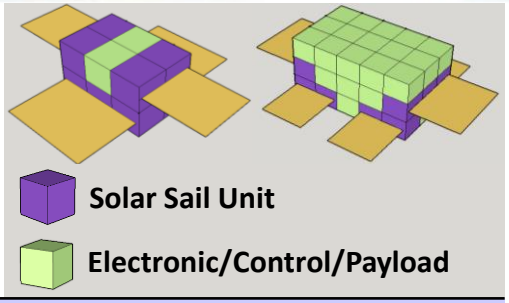


Three ways to steer the solar sail
1. Rotate the whole spacecraft
2. Tilt the blades to change angle of solar pressure
3. Retract/extend the blades to change CP relative to CM

Retractable solar sail system: control CM/CP*, avoid thermal heat flux

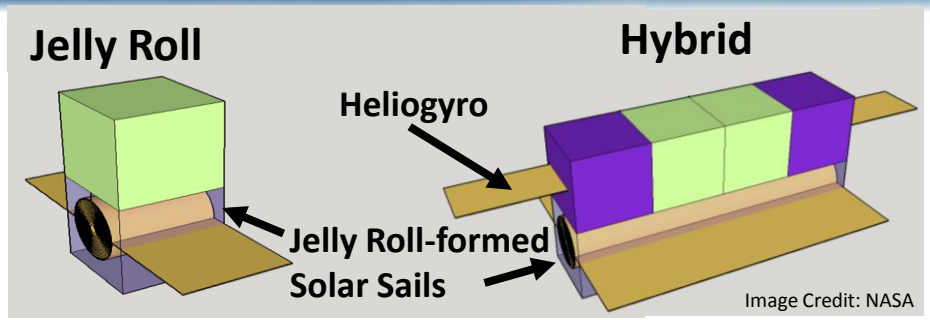
CM = center of mass, CP = center of pressure

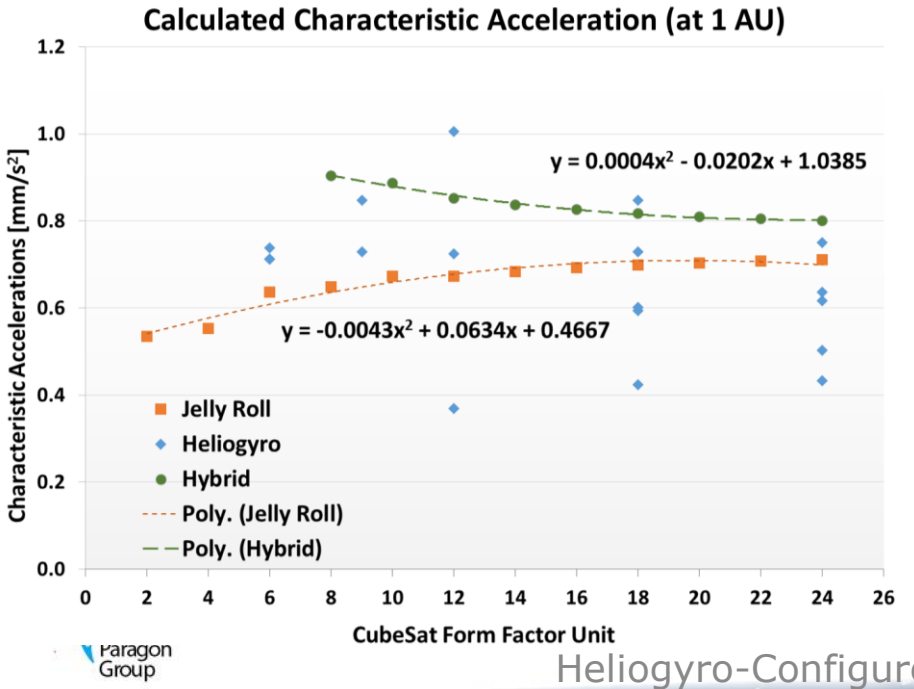
Background Image Credit: NASA http://www.nasa.gov/mission_pages/hubble/multimedia/index.html?id=355696

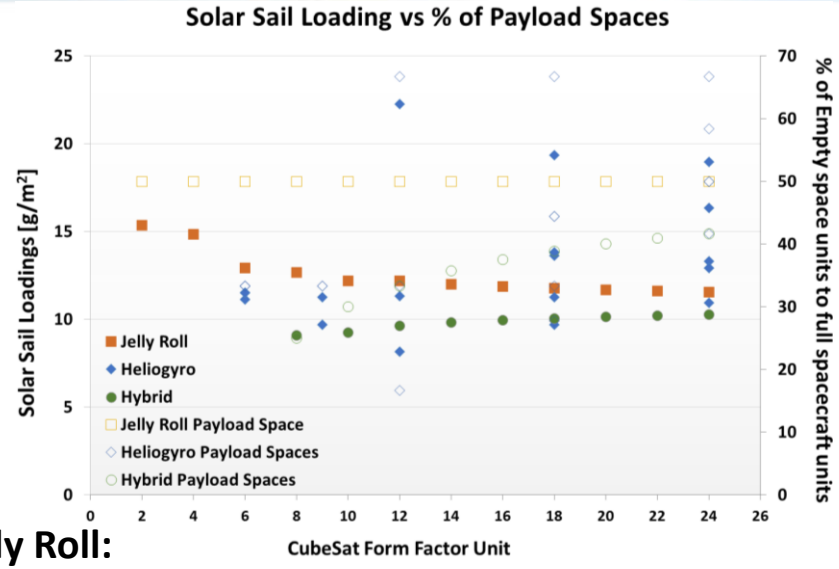


Heliogyro	Characteristic Acceleration [mm/s²]	Sail Loading [g/m²]	% of payload units to the whole spacecraft units	
18U-4B(a)	0.85	9.68	33	28-41%
18U-8B(a)	0.73	11.25	28	
24U-4B(a)	0.75	10.94	41	
24U-4B(b)	0.62	13.30	59	50-60%
24U-4B(c)	0.64	12.90	50	
30U-4B(a)	0.61	13.56	53	
36U-4B(a)	0.58	14.13	56	
42U-4B(a)	0.57	14.38	57	
48U-4B(a)	0.56	14.58	58	

> 55% of payload units → small accelerations
< 40% of payload units → large accelerations
Suggest: payload units < 40%, ~ 33% is the optimum







Jelly Roll:
≤12U → low to mid-range characteristic accelerations compare to Heliogyro configurations.

Hybrid:
Accelerations stay in the high range of Jelly Roll and Heliogyro with insignificant decreases in accelerations as the size increases.
The hybrid's sail loading does not dramatically increase with size.

Summary

Heliogyro:

Large accelerations (> ~0.7 mm/s^2), suggest < 40% of payload units, ~ 33% is the optimum

Jelly Roll and Hybrid (Combination of Jelly Roll and Heliogyro)

Suggest: payload space ~30 – 40% of the payload space to produce > 0.8 mm/s^2.

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